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(71) Applicant
Airship Industries (UK) Limited

(Incorporated in United Kingdom)

Bond Corporation House, 347-353 Chiswick High Road,
London W4 4HS

(72) Inventor
James Arthur Iain Reid

(74) Agent and/or Address for Service
Boult, Wade & Tennant,
27 Fumival Street, London EC4A 1PQ

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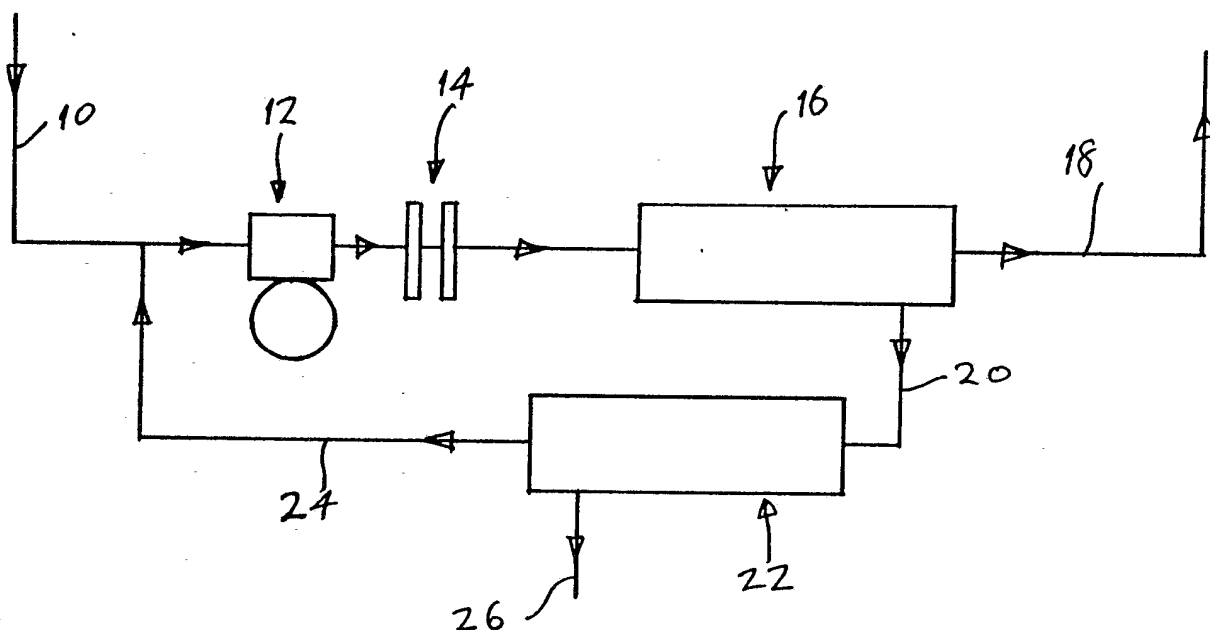
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(54) A dirigible

(57) A dirigible, in which the lifting gas is helium, has a car which includes an on board helium purification apparatus comprising a compressor 12 and a membrane filtration unit 16. Helium is drawn from the envelope via a line 10, the purified helium being returned to the envelope via a line 18. A line 20 from the waste outlet of filtration unit 16 feeds a second filtration unit 22, helium recovered from this unit returning via a line 24 to the main circuit at line 10.

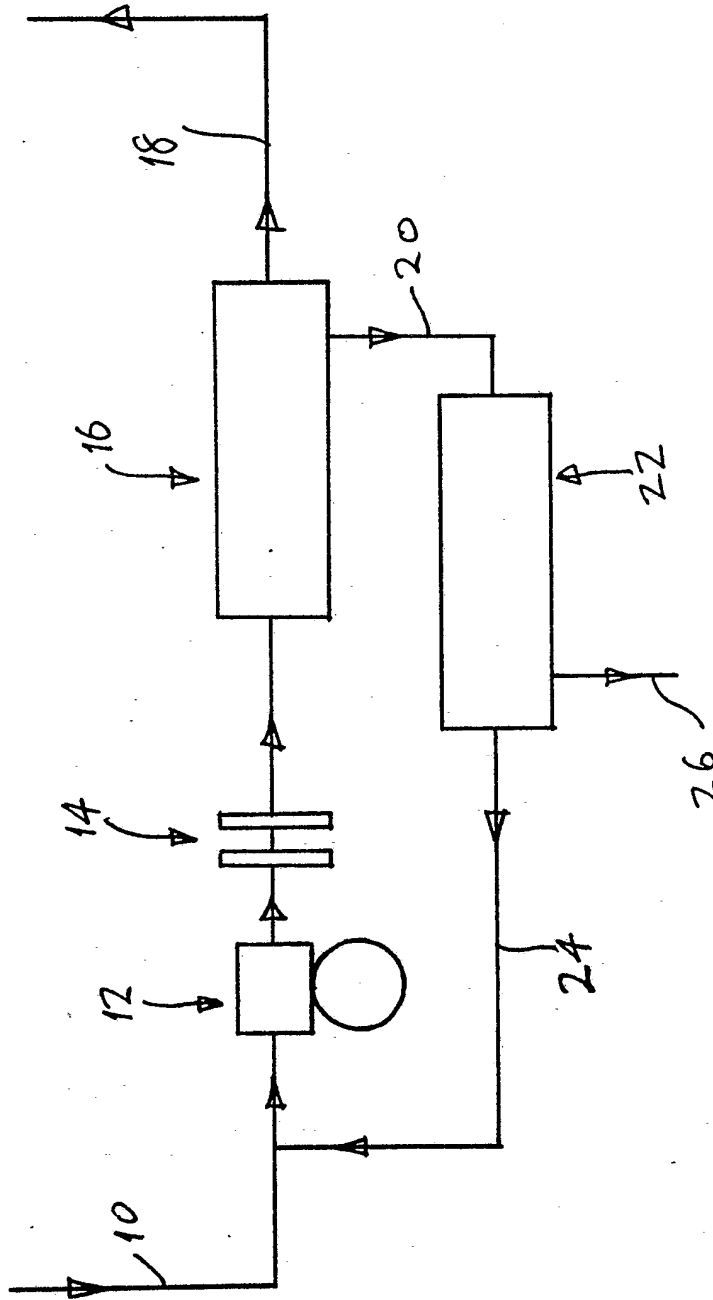


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SPECIFICATION

A dirigible

- 5 This invention concerns a dirigible, that is a navigable airship or navigable power driven aerostat, in which the lifting gas is helium.
- Gas retaining membranes have the physical characteristic of possessing a measurable gas permeability in both directions, even if one side is under a positive pressure. Thus the material of a dirigible or airship envelope or gas cell, while slowly allowing some lifting gas (helium) to escape, will also allow air to pass
- 10 into the enclosed space, contaminating the gas and reducing its lifting power. Typically air migrates inward at one quarter of the rate that helium migrates out.
- This contamination problem is aggravated
- 20 by the presence of any leaks, the mean free speed of the molecules in air being quite sufficient to overcome the exit velocity of the escaping gas, causing air to enter the chamber and increase the contamination.
- Hitherto, the normal practice has been to continue operation of a helium filled airship until the purity reaches a minimum acceptable limit and then to withdraw the ship from service and purify the helium. Thus not only is the airship operating for appreciable periods below its maximum capability but also it is unavailable during the purification process which can occupy a number of days.
- Purifying plants, typically of the cryogenic or absorption type are heavy and bulky and only suitable for operation at a fixed base. Recent developments in gas technology have resulted in the introduction of membrane filtration units which are capable of removing the impurities
- 40 from a stream of contaminated helium, the product being of a purity adequate for airship applications. A membrane (or molecular) filtration unit normally uses layers of cellulose esters perforated by tiny uniform holes.
- The invention provides a dirigible, in which the lifting gas is helium, with an on board helium purification apparatus comprising a compressor, a membrane filtration unit and connections for removing gas from the envelope, passing it to the compressor and then to the membrane filtration unit and returning purified helium to the envelope.
- 50 With such an installation a small plant, running continuously, can dispose of the impurity as it occurs, maintaining the purity of the lifting gas at a very high value. The weight of such a plant will be a small proportion of the loss of lift obtaining when the ship is run down to a minimum purity value before requiring connection to a base purifying plant. The lifting power is maintained at a constant value and time-out-of-service for purification is no longer required.
- 60 In order to minimise the loss of helium in the waste from the filtration unit, preferably
- 65

the helium purification apparatus comprises a second membrane filtration unit the inlet of which is connected to the waste outlet of the first unit, and the outlet of which for the purer helium is connected to the upstream side of the compressor.

70 An embodiment of the invention will now be described by way of example and with reference to the accompanying drawing, which is a block diagram of a helium purification apparatus.

In the diagram, helium mixed with impurities, mainly air, is taken from the envelope along a line 10 and fed to a compressor 12. After being compressed, the gas is passed through filters 14 to remove oil and water. From the filters 14, the gas is fed into a first membrane filtration unit 16 and the cleaned and purified helium is fed back along a line 18 to the envelope. The waste outlet of the first unit 16 is connected by a line 20 to the input of a second membrane filtration unit 22. The cleaned and purified helium from this second unit 22 is connected by a line 24 to the line 10 upstream of the compressor 12. The outlet of the second unit 22 is connected by a line 26 to atmosphere.

The purity of the helium taken from the envelope along line 10 is typically 94%, and that returned along line 18 typically 99.5%.

95 The compressor 12 is run from the power plant for the dirigible.

The apparatus is carried in the car of a dirigible and the lines 10 and 18 pass through the top of the car into the envelope and open at opposite ends of the envelope.

CLAIMS

1. A dirigible, in which the lifting gas is helium, with an on board helium purification apparatus comprising a compressor, a membrane filtration unit and connections for removing gas from the envelope, passing it to the compressor and then to the membrane filtration unit and returning purified helium to the envelope.
2. A dirigible as claimed in Claim 1, wherein the helium purification apparatus comprises a second membrane filtration unit the inlet of which is connected to the waste outlet of the first unit, and the outlet of which for the purer helium is connected to the upstream side of the compressor.
3. A dirigible as claimed in Claim 1 or 2, wherein oil and water are removed between the compressor and the first membrane filtration unit.
4. A dirigible substantially as herein described with reference to and as shown in the accompanying drawing.